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A Generalized Fact and Model of Long-Run Economic Growth: Kaldor Fact as a Special Case

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Abstract

This paper provides new evidence on the long-run relationship between economic growth and labor's share in national income, based on a comprehensive panel data set for 123 countries from 1950 to 2004. Xie's primary finding is that labor's share follows a cubic relationship with real GDP per capita over the long process of development. At the beginning of the modern economic growth process, the share of labor in national income first decreases until an initial threshold is reached. After that, labor's share keeps increasing until the country's GDP per capita reaches a second threshold before falling again. Xie argues that these dynamics apply not only to the less developed countries in the postwar years, but also to the advanced countries like the United States and the United Kingdom during their early economic take-offs, starting in the late 18th and 19th century, respectively. Finally, he proposes a two-sector constant elasticity of substitution (CES)-type growth model and simulates the model to replicate and explain the possible mechanism behind such a nonlinear pattern of movements in labor's share.

JEL Codes: O41, P21, E32.
Keywords: Constant elasticity of substitution, Kaldor fact, Kuznets curve, Labor's share, Structural change.

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1 INTRODUCTION

One of the most important empirics upon which the modern growth theory is built (Solow 1957) is that the labor and capital shares in national income are roughly constant over time. As one of his six stylized facts, Kaldor (1957) summarized it as, "It was known for some time that the share of wages and the share of profits in the national income has shown a remarkable constancy in 'developed' capitalist economies of the United States and the United Kingdom since the second half of the 19th century." This echoes Keynes' surprise (1939), "I mean the stability of the proportion of the national dividend accruing to labor, irrespective apparently of the level of output as a whole and of the phase of the trade cycle. This is one of the most surprising, yet best-established, facts in the whole range of economic statistics, both for Great Britain and for the United States… It is the stability of the ratio for each country which is chiefly remarkable, and this appears to be a long-run, and not merely a short-period, phenomenon." On the other hand, Kuznets (1959) challenges the view of constancy of factor shares cross country or over time. Most recently, there has been a small literature trying to reconcile the Kaldor fact with structural transformation, for example, Kongsamut, Rebelo, and Xie (2001); Ngai and Pissarides (2007); and Acemoglu and Guerrieri (2008).

In this paper, I will provide new empirical evidence on the long-run relationship between economic growth and labor's share in national income. I construct a comprehensive panel data set of labor's share for 123 countries from 1950 to 2004 (most countries in this data set have data available from 1970 to 2004). *My primary finding is that labor's share tracks a cubic relationship with real GDP per capita over the long process of development*. At the beginning of the economic take-off, the share of labor in national income will first decrease until a threshold of US$3,000 is reached (denominated in 2000 constant US dollars). With empirical support from the latest research in economic history, I would also argue that this pattern applies not only to the less developed countries since 1950, but also to the advanced countries like the United States and the United Kingdom in their earliest stages of development. After this first threshold is passed, labor's share will keep increasing until the country's real GDP per capita reaches the next threshold, around US$15,000. After that, labor's share will follow a downward trend again. To explore the mechanism behind such nonlinear and non-monotonous movements in the labor's share, I build a growth model based on a two-sector constant elasticity of substitution (CES) production function and consumer preference specification, following Engel's law. *In short, my findings can be seen as a generalization of the Kaldor fact and Solow-type growth model, to characterize the panoramic process of modern economic growth*.

The emphasis on structural transformation can be traced back to Simon Kuznets, who summarizes the main quantitative characteristics of modern economic growth in his Nobel Prize lecture (Kuznets 1973), "…the rate of structural transformation of the economy is high. Major aspects of structural change include the shift away from agriculture to nonagricultural pursuits and, recently, away from industry to services; a change in the scale of productive units, and a related shift from personal enterprise to impersonal organization of economic firms, with a corresponding change in the occupational status of labor." Kuznets identifies two grand transformations. The first is industrialization, during which economic resources are transferred from the agricultural or feudal sector to the industrial sector. However, the timing of industrialization varies tremendously among countries. The Industrial Revolution in Great Britain, the first industrialization in human history, started from the end of the 18th century, while some emerging economies like China are experiencing a similar process two centuries later. The second transformation is from industry to services. *Beyond Kuznets, I will provide new evidence and ascribe the second decline of labor's share in my empirical findings to a possible ongoing third economic transformation, the rise of the finance and real estate sector in the later phase of economic development*.

Kuznets (1955) was among the first researchers to deal with the inequality problem in early economic development, as summarized by the classical "Kuznets Curve." As the size of agriculture shrinks, the size of industry grows, and inequality increases due to the large gap between the two sectors. In a classical framework, Lewis (1954) assumes the real wage is fixed in terms of agricultural goods and that there will be disguised unemployment before it can be consumed by the industrial sector. With Lewis' oversimplified model, it is very easy to explain why labor's share will go down at the beginning of industrialization: because of the surplus labor and stagnation of the wage. In contrast, Jorgenson (1961, 1967) and Ranis and Fei (1961) successfully applied a neoclassical approach to modeling the transitional process.

In the recent literature, Blanchard (1997, 1998), Caballero and Hammour (1998), Rodrik (1999), Acemoglu (2003), Blanchard and Giavazzi (2003), and Bentolila and Saint-Paul (2003) have explored various factors behind the movements of labor's share, mainly focusing on the OECD countries in the postwar period. Young (2006) uses postwar US data to challenge the relatively constancy of aggregate factor shares, following the methodology of Solow (1958). Ruiz (2005) provides empirical evidence on the nonconstancy in factor shares for Spain using its time series data from 1955 to 2005. In contrast, my research emphasizes the movements of labor's share in long-run economic development and transformation, with the least developed countries included. On the other hand, Gollin (2002) and Bernanke and Gurkaynak (2001) design delicate methodologies to adjust labor's share for the developing countries. With their adjustment for the noncorporate sector in developing countries, labor's share is pulled closer to the level of the developed world. However, they limit their exploration to cross-country comparisons and do not take into consideration the possibility of nonlinear dynamics in different stages of development.

The seminal paper by Arrow et al. (1961) proposed the CES production function with empirical support. Leontief (1964) also criticized the Cobb-Douglas function, "…whenever a working economist was called on to describe in numbers or to interpret in analytical terms the relationship between the inputs of capital and labor and the final product of a plant, an industry, or a national economy as a whole, he was more likely than not to reach out for the Cobb-Douglas production function… But now this remarkable career is apparently coming to an end. The old formula is being rapidly replaced by a new, improved recipe: the constant elasticity of substitution production function…" Most recently, Duffy and Papageorgiou (2000) revived a literature in economic growth and adopted the CES-form production function. Acemoglu (2003) assumes an elasticity of substitution that is lower than one. Estimates by Antras (2004) for the United States suggest an elasticity lower than one, even probably below 0.5. Solow (2008) presents a review of this new small literature. My theoretical model is built upon a new two-sector CES specification.

Another literature related to my research is the Unified Growth Theory initiated by Galor and Weil (2000) and Hansen and Prescott (2002). This literature intends to integrate the Malthusian stagnation with modern economic growth in a unified framework.

This paper is organized as follows. Section 2 presents my main empirical findings characterizing the evolution of labor's share during long-run development. Section 3 offers sectoral analysis of the movements in labor's share and examines the empirical evidences behind the three economic transformations. Section 4 tries to test my empirical findings with the economic history of the United Kingdom and the United States. Section 5 develops a two-sector unified growth model, aiming at explaining the nonlinear and nonmonotonous dynamics of labor's share. Section 6 performs a simple simulation based on the proposed growth model. Section 7 concludes the paper.

2 EVOLUTION OF LABOR'S SHARE AND NEW PANEL ANALYSIS

In this section, I will present new empirical results on the movements of labor's share in national income. In section 2.1 I first discuss various definitions of labor's share and explain why I choose my own definition. Section 2.2 shows the main panel regression results. In section 2.3 I provide additional robust checks, using a variety of control variables.

2.1 Various Definitions of Labor's Share

The simplest definition of labor's share in national income is the ratio of compensation to the employees to GDP minus indirect taxes as (1),

$$Labor\ Share = \frac{Corporate\ employee\ compensation}{GDP - indirect\ taxes} \quad (1)$$

These data are generally available in the *United Nations System of National Accounts*. However, according to this simple formula, some countries seem to have too low of shares of labor income. Gollin (2002) attributes the abnormally lower value of labor's share in many developing countries to the failure of incorporating the income of the self-employed and noncorporate employees into the "employee compensation." Gollin thus names specification (1) as a naive method and improves the measure of labor's share by adopting several adjustments. One of Gollin's well-accepted corrections is shown by (2),

$$Labor\ Share = \frac{Corporate\ employee\ compensation}{GDP - indirect\ taxes - OSPUE} \quad (2)$$

After this adjustment, some countries' labor shares are boosted up significantly. Bernanke and Gurkaynak (2001) generally confirm Gollin's methodology, and they especially prefer the estimation formula of (2).

The other method is to adjust the GDP data by assuming the corporate and noncorporate workers receive the same average earnings, as calculated by (3),

$$Labor\ Share = \frac{Corporate\ employee\ compensation}{\frac{Corporate\ employees}{Total\ labor\ force - unemployed} \times (GDP - indirect\ taxes)} \quad (3)$$

Bernanke and Gurkaynak (2001) also proposed the imputed operating surplus of private unincorporated enterprises (OSPUE) method, by (4) and (5),

$$Labor\ Share = \frac{Corporate\ employee\ compensation}{GDP - indirect\ taxes - \mathrm{Im}puted\ OSPUE} \quad (4)$$

$$\mathrm{Im}puted\ OSPUE = \frac{Total\ labor\ force - unemployed - Corporate\ employees}{Total\ labor\ force - unemployed} \times (Operating\ Surplus + Corporate\ employee\ compensation) \quad (5)$$

Admittedly, the Gollin method of adjustment can help to mitigate some of the anomalies, for example: Without adjustment, Niger's labor share is calculated as about 16 percent with the naive method, but rises up to around 60 percent with the adjustment. However, as Bernanke and Gurkaynak (2001) put, there are only a few countries that have OSPUE (or mixed income) data available. Gollin (2002) covers only about 30 countries. Bernanke and Gurkaynak (2001) expand the coverage to about 50 countries. I finally gathered data for about 60 countries that have data available that satisfies the demands of (2). My dataset covers about 2,700 observations of employees' compensation, of which only 800 observations have corresponding mixed income data. Moreover, taking a close look at the data, I find countries with mixed income data available are either developed countries or poor countries only having a few observations.

Moreover, according to my analysis, disparate calculating methodologies do not change much the relative time series trend in the movements of the labor share for a specific country. In table 1, I show the correlation between the naive measure (1) and sophisticated measure (2). The dependent variable is the "classical" definition of labor's share by Gollin (2002). The correlation is high. In particular when I control the country fixed effect in column (3), I get a coefficient very close to 1.

In addition, there are some limitations for these adjustment methods. The explicit or implicit intention of the adjustments proposed by Gollin (2002) and followed by Bernanke and Gurkaynak (2001) is to narrow the analysis within the formal sector, or the modern corporated sector. It might be good enough for modern economic analysis, but it will mask many facts that are essential for studying long-run development, as emphasized by Kuznets, "the shift from personal enterprise to impersonal organization of economic firms" as well as the dual economy emphasized by Jorgenson (1961).

Gollin (2002) only conducts cross-country analysis, so do Bernanke and Gurkaynak (2001). Gollin (2002) finds some relatively poor countries like India had a labor's share as high as 0.84 in 1980, and Vietnam got the same number in 1989. These numbers are even much larger than that of the United States and Japan. A hypothesis to reconcile these seemingly abnormal facts is that a country's labor income share might firstly decrease at the beginning of economic development and then rise again at a later stage. Cross-country analysis in previous research cannot capture these interesting and crucial dynamics, especially during economic transformation.

2.2 Primary Panel Analysis

In this research, I adopt the panel method with fixed effects, so the naive measure of labor's share can be good enough when the country-specific characteristics are controlled. Although different countries could have disparate shares of a self-employed (not incorporated) sector, which can be captured by the constant item in a fixed effect panel model, the comovement of labor's share in the (formal) incorporated sector and the whole economy seems to be fairly high, as proved in table 1. The main purpose of this research is to explore the long-run movements of labor's share over time, so the panel method with fixed effects is an appropriate choice.

My new empirical exploration is based on several major databases, including the United Nations System of National Accounts, the EU KLEMS Growth and Productivity Accounts, various national sources, as well as the latest research findings for various countries. If a country's labor share data is covered by different sources, I prefer to choose the data source with the longest time series. Even if different countries may use disparate definitions of labor's share, panel methodology can help to correct this because I care mainly about the evolution over time within a country. For national GDP data, I use the Penn World Table (PWT6.2) real GDP per capita (*rgdpch*, chain series), i.e., international dollars in 2000 constant prices. Labor's share in national income follows equation (1).

The primary panel regression results are shown in table 2. Columns (1) and (2) use the yearly data with country fixed effects controlled. Column (1) also controls the time fixed effect of each year, whereas column (2) treats time as a linear variable. Columns (3) and (4) illustrate the panel regression results with all variables in five-year averages, as in the standard growth regression practices. In addition, I also try specifications of quadratic and higher power relationships with 1n(*rgdpch*) in columns (5) and (6), in which the coefficients are not statistically significant.

The basic findings in table 2 illustrate a strong cubic relationship between labor's share and the level of economic development. It is reasonable to think the commodity exporters might have a different economic structure—very disparate sector compositions and thus "disturb" the relationship between the labor's share and GDP level. Therefore, I have additionally checked this relationship by removing the commodity exporters, and show the new regression results in table A1. The cubic relationship is kept very well after removing the most important 22 commodity exporters (in terms of the commodity exports value to GDP ratio).

2.3 Robustness Checks with Standard Controls

In this section, I add standard control variables used in the long-run economic growth literature. All exercises in this subsection are panel regressions with both country and time fixed effects. The new results are presented in table 3. All variables are in five-year averages.

Firstly, in all the exercises the cubic relationship between the labor's share and the per capita GDP level is very robustly kept. In column (1) I add the updated school year variable by Barro and Lee (2000). Column (2) illustrates that the average human capital level follows a *reversed U-shape* relationship with labor's share. Investment generally increases the labor's share with other factors controlled, although this relationship is not always robust. However, population growth rate, institutional quality (from the Polity Project, as preferred by the present growth literature), and openness do not have very strong statistical relationships with the labor's share over time. Column (5) shows that inflation has a strong, negative correlation with labor's share, which is consistent with research elsewhere. In table A2 I show the corresponding regression results with the commodity exporters removed, and no obvious changes are found in the value and significance of the new set of coefficients.

I can recover and characterize the explicit relationship between the labor's share and real GDP per capita according to the coefficients derived from these regressions. Figure 1 exemplifies this long-term relationship diagrammatically. The horizontal axis lines out the per capita real GDP level. After an economy just moves onto the track of modern economic growth, its labor's share will firstly experience a continuous drop until the first minimum value is attained. I can solve this numerically. The first minimum of the labor's share is reached at GDP level around US$3,000 in per capita terms (in 2000 constant US dollars). After passing this first turning point, the labor's share begins to rise monotonously for quite a long time with the economic growth going on. Then the second turning point, a local maximum is reached. I can solve and see this local maximum of labor's share is approximately arrived at a per capita GDP level of US$15,000 (in 2000 US dollars). The modern economic growth theory and the Kaldor fact have mainly focused on the smoother portion of the curve, and this is why a constant labor's share is generally assumed and agreed on.

To depict this with real data, in figure 2 I scatter the labor's share versus real GDP per capita with pooled data for four periods, 1970–74, 1980–84, 1990–94, and 2000–2004. Moreover, figures 3–6 demonstrate all countries' data in each period respectively along with the fitted curves.

This can also help to explain the "puzzles" encountered in the research of Gollin (2002) and Bernanke and Gurkaynak (2001): Why do some poor countries have such high labor's share? The nonlinear and nonmonotonous movements of the labor's share as demonstrated by figure 1 could provide a feasible answer. It just so happens that many least developed countries are located on the portion of the curve before the first turning point and are undergoing a durative reduction in labor's share right now. This will be confirmed with detailed discussions on what is happening in the present China and India in the next section (*section 3.2*). At the same time, many middle-income countries have marched to the portion of the curve between the first local minimum and the local maximum, and so they are currently seeing a gradual rise in their labor's share. This will be discussed in detail in *section 3.3*. Finally, a small number of developed countries have arrived at the third part of the curve after exceeding the second turning point and will endure a drop in their labor's share again. I describe this recent stage of development as "financialization" and will conduct deeper analysis in *section 3.4*.

3 BEHIND THE VEIL OF THE LONG-RUN MOVEMENTS IN LABOR'S SHARE

I attribute the nonlinear and nonmonotonous pattern in the movements of labor's share to the grand economic transformations. Some researchers like Kuznets stress the importance of production transformation, while others like Engel underline the evolution of the consumers' preferences. Probably these two forces have joined together to stimulate the unremitting evolution of the national economy as well as labor's share. In this section, I conduct a sectoral decomposition analysis of the change in labor's share over time to prepare for later statistical explorations. I then go on to discuss the three grand economic transformations that have happened or are happening right now.

3.1 A Sectoral Decomposition in the Evolution of Labor's Share

I denote the change of aggregate labor's share in the whole economy from t to $t + 1$ by $\Delta L = L_{t+1} - L_t$. Labor's share at time $t + 1$ can be decomposed into sectors following (6). I assume there are K economic sectors in total, and $v_{i,t+1}$ represents the value-added share of sector i at time $t + 1$. Thus I have $\sum_{i=1}^{K} v_{i,t+1} = 1$.
I use $\Delta v_i = v_{i,t+1} - v_{i,t}$ to represent the change of value-added share of sector i rom t to $t + 1$. Labor's share of sector i at time $t + 1$ is $l_{i,t+1}$, and $l_{i,t+1} - l_{i,t} = \Delta l_i$.

$$\sum_{i=1}^{K} v_{i,t+1} \cdot l_{i,t+1} = L_{t+1} \quad (6)$$

Because $\sum_{i=1}^{K} v_{i,t+1} \cdot L_t = \sum_{i=1}^{K} v_{i,t} \cdot L_t = L_t$, I can use (7) to decompose ΔL by sectors. From time t to t + 1 sector i 's additional deviation from the aggregate labor's share at t is represented by $v_{i,t+1} \cdot (l_{i,t+1} - L_t)$, which is the product of the sector's value-added share at time $t + 1$ and the deviation of its sectoral labor's share at time $t + 1$ from the aggregate labor's share of time t.

$$\sum_{i=1}^{K} v_{i,t+1} \cdot (l_{i,t+1} - L_t) = \Delta L \quad (7)$$

I further decompose (7) by changes of sectoral value-added shares and labor's share, following (8) and (9). In (9) I use $\bar{l}_{i,t}$ to represent $l_{i,t} - L_t$, which means the deviation of the sectoral labor's share from the aggregate labor's share at time t.

$$\sum_{i=1}^{K} [v_{i,t} + \Delta v_i] \cdot [\Delta l_i + (l_{i,t} - L_t)] = \Delta L \quad (8)$$

$$\sum_{i=1}^{K} [v_{i,t} \cdot \Delta l_i + v_{i,t} \cdot \bar{l}_{i,t} + \Delta v_i \cdot \Delta l_i + \Delta v_i \cdot \bar{l}_{i,t}] = \Delta L \quad (9)$$

There are four components in the decomposition equation (9):

(1) $v_{i,t} \cdot \Delta l_i$: the pure within-sector change effect of the labor's share, given a constant value-added share as in time t

(2) $v_{i,t} \cdot \bar{l}_{i,t}$: the deviation of sector i 's labor's share from the average level at time t. This describes sector i 's idiosyncrasy in terms of its labor income share.

(3) $\Delta v_i \cdot \Delta l_i$: the joint effect of the sectoral size change and within-sector labor share change

(4) $\Delta v_i \cdot \bar{l}_{i,t}$: the pure effect of sectoral size change given a constant labor's share as in time t

I notice $\sum_{i=1}^{K} v_{i,t} \cdot \bar{l}_{i,t} = 0$, and then the decomposition can be rewritten as (10),

$$\sum_{i=1}^{K}[v_{i,t} \cdot \Delta l_i + \Delta v_i \cdot \Delta l_i + \Delta v_i \cdot \bar{l}_{i,t}] = \Delta L \quad (10)$$

Therefore, the components (1) (1) $v_{i,t} \cdot \Delta l_i$, (3) $\Delta v_i \cdot \Delta l_i$, and (4) $\Delta v_i \cdot \bar{l}_{i,t}$ capture the three types of sectoral contribution to the aggregate change in the national labor's share from time t to $t + 1$.

3.2 The First Grand Transformation: Industrialization

Agriculture in many developing countries has very high labor's share. In premodern society agricultural production is mainly conducted by the farmers' hands largely without the help of capital-intensive equipment. After industrialization is finally completed, agriculture will become a capital-intensive sector with new supplies of mechanical equipment and fertilizers from the industrial sector, as evidenced by the experiences of OECD countries.

Subramanian (2008) raises concern about sluggish wage growth in China. According to Bai and Qian (2009), labor's share in China's agriculture is around 0.85 and has been relatively stable from 1978 to 2004. This value is much higher than that in industry and services. In the past 15 years, labor's share in industry has kept decreasing whereas that in the services sector is relatively constant. The joint effect is a significant drop in the aggregate labor share in the national income in recent years, which has provoked concerns and discussions in China. This is consistent with the reported 4 percentage point reduction in average wage's share from 1995–2000 to 2001–06 by ILO (2008). Nevertheless, in light of my new empirical findings in section 2, the reduction in labor's share at the present development stage seems to be unavoidable and the turning point should be coming very soon. Figure 7 has shown such a possible trend from 2003 to 2004, although I do not have the latest data to further verify this hypothesis.

Shastri and Murthy (2005) provide a similar pattern in a considerable drop of wage's share in organized Indian industry between 1973 and 1997. During this period, labor's share in the organized Indian industry decreased by 19 percent, falling from 51.7 percent to 32.8 percent, as shown in figure 8. RUPE (2008) points out that National Sample Survey (NSS) of 2004–05 shows a decline in real wages for urban workers (male and female, regular salaried and casual) over the NSS (1999–2000). Wage levels of workers are declining not only in the unorganized sector but also in the organized sector. Simultaneously the share of profit in value added in the organized sector is found to be rising. This echoes a report from the National Commission on Enterprises in the Unorganized Sector (NCEUS 2007). The wage share in my organized industrial sector has halved after the 1980s. Although ILO (2008) does not provide India's wage's share data, the average real wage growth rates for the periods 1995–2000 and 2001–07 are reported to be 1 percent and 1.6 percent respectively, significantly lower than the real GDP growth rates. I plot in figure 9 the labor's share of the Indian economy since 1980, which confirms such a declining trend.

3.3 The Second Grand Transformation: Toward the Postindustrial Society

Following the industrialization process, modern services begin to expand simultaneously. Furthermore, at a later stage, the share of the services sector will continue to expand at the expense of industry. This procedure is sometimes called deindustrialization. Labor's share will keep increasing in this process.

Ruiz (2005) presents a detailed analysis for both Spain and the United States from 1955 to 2005 regarding their sectoral value-added size, within-sector labor's share, and aggregate labor's share in the national economy. Figure 10 illustrates the evolution of the labor's share relative to GDP per capita for Spain. In 1955, real GDP per capita in Spain was higher than US$4,000, past my first turning point of US$3,000 derived in section 2. So I think Spain from 1955 to 2005 is a good example to showcase the later stage of industrialization as well as deindustrialization. The Spanish aggregate labor's share has kept increasing from 1955 to the 1980s. Interestingly, labor's share in Spain fluctuated for a while in the 1990s and then started a downward trend. The PWT6.2 shows that Spain achieved a real GDP per capita level of US$15,000 in 1990. Therefore, the Spanish case is very consistent with my new panel econometric findings.

Spain's industrial sector was relatively stable at about 30 percent of GDP from 1955 to 1987; since then, it has dropped to about 20 percent, ending in 2005. Spain in 1959 had a relatively smaller services sector at 35 percent of the economy, whilst the United States in 1958 had already developed a services sector as large as 54 percent of the GDP. The share of the Spanish services sector has risen to 59 percent in 2005, which is comparable to the United States in the mid-1980s.

3.4 The Third (Ongoing) Transformation: Financialization and the Recent Rise of the Finance and Real Estate Sectors in Developed Countries

Many researchers have recognized the recent changes in labor's share in the OECD countries, e.g., Blanchard (1997,1998), Caballero and Hammour (1998), Rodrik (1999), Acemoglu (2002, 2003), Blanchard and Giavazzi (2003), and Bentolila and Saint-Paul (2003). They have examined a variety of potential contributors behind this, including nominal macro factors, institutional differences, labor markets, biased technical change, and monopoly.

I exploit the new *EU KLEMS* database to take a close look at the sectoral evolvement for the OECD countries (the industrial classification in the *EU KLEMS* is close to ISIC rev. 3). To mitigate short-term fluctuations, I compare the five-year average of 1975–79 period (denoted as 1975 for simplicity) with the 2000–2004 (simply put as 2000). I then average the 16 OECD countries that have data available for 1975–79. Table 4 shows a detailed decomposition of the main sectors.

I separate the services sector into financial services and nonfinancial services because these two subsectors have behaved very differently. Column (1) shows the changes in the aggregate labor's share. I can see a 3.3 percent average reduction from 1975 to 2000. $\bar{l}_{i,1975}$ and $\bar{l}_{i,2000}$ represent the deviation of the sectoral labor's share from the aggregate labor's share in year 1975 and 2000 respectively. The further decomposition of the sectoral effects into (1), (2), (3), (4) follows the definitions in section 3.1. The sum of (1), (3), (4), as shown in the bottom row, illustrates the sectoral contribution to the change in labor's share between 1975 and 2000. Although agriculture has the lowest labor's share, its relative size in the economy is very small (5.9 percent in 1975 and down to 2.2 percent in 2000). Labor's share in the financial services sector is around 35 to 38 percent, which is more than 30 percent lower than the industry and the nonfinance services.

From table 4, I can see agriculture in these developed countries has had a positive contribution to the change of aggregate labor's share. Industry reduced the aggregate labor's share by 2.6 percent. Moreover, the effect of (1) $v_{i,t} \cdot \Delta l_i$ for industry dominates other effects. This gives strong support that biased technical change, i.e., labor-saving technical innovations could have been the major cause of the decrease in labor's share within industry, as argued by Acemoglu (2002, 2003).

During the same period, the financial services also had a significant impact on the aggregate labor's share by reducing it by 1.65 percent. Notably, this effect mainly comes from the effect of sectoral size change (4) $\Delta v_i \cdot \bar{l}_{i,t}$ by –2.44 percent. That is, the financial sector lessened the aggregate labor's share mainly due to its relative size expansion in the economy. I can see from the row Δ [1975–2000], the value-added share of the financial services sector gained in more than 10 percent from the total economy mainly at the expense of the industry (–8.9 percent). Interestingly, the contributors in these two sectors are disparate: For industry, it is through within-sector change of labor intensity; for the financial sector, it is due to the relative increase of the value-added share in the economy.

To understand movements within the financial services, I decompose it further and show the subindustry statistics in table 5.

Real estate activities (corresponding to the ISIC rev. 3 industrial code 70) have an extremely low value in terms of labor's share (6 percent). Moreover, the real estate sector is found to be the main cause of labor's share drop within the financial services (–1.84 percent). Once again, the expansion of the size of the real estate sector is the dominant factor that contributes to the drop in labor's share, i.e., (4) $\Delta v_i \cdot \bar{l}_{i,t}$ by (–1.75 percent).

In sum, sectoral analysis in this section generally confirms my previous findings and helps us to understand the disparate dynamics behind these three types of grand economic transformations at different development stages.

4 EVIDENCE FROM THE ECONOMIC HISTORY

Modern growth theory is largely built upon the empirical facts of the United Kingdom and the United States since the beginning of the 20th century. Most of the recent revisits of the problem on labor's share only cover OECD countries after WWII. The earliest GDP data available in the PWT is in 1950, when the United States had reached a per capita GDP level of US$11,233 and the United Kingdom arrived at US$8,081. The economic development level of both the United States and United Kingdom has been well above the first turning point of US$3,000. No wonder the relative constancy of labor's share has been observed by many prominent researchers. In this section, I will try to make use of the evidence in the economic history to examine whether my new empirical findings are equally applicable to these developed countries in an early stage of development.

4.1 The United Kingdom, 1500–2004

The first industrial revolution in human history originated in the United Kingdom in the later part of the 18th century. As Landes (1969) summarizes, "… In the eighteenth century, a series of inventions transformed the manufacture of cotton in England and gave rise to a new mode or production—the factory system … These improvements constitute the Industrial Revolution."

Lindert and Williamson (1983) conducted the first rigorous economic analysis of the English worker's living standards during the Industrial Revolution. Their new evidence endorsed an optimistic view of a rapid rise of the workers' real wages. Recently economic historians have discovered new evidence supporting the viewpoint of real average wage stagnation relative to the output during the industrial revolution of the United Kingdom. Feinstein (1998) estimates that over about 80 years from 1770 to 1850, the increase in real earnings was less than 30 percent (his estimates were at 10 to 15 percent). Figure 11 (from Allen 2007) demonstrates an obvious lag between the real wage growth and output growth: The real wage index rose by only 12 percent between 1780 and 1840, while the output per worker rose by 46 percent.

Allen (2007) also discusses the long-term evolution of the functional distribution of the British national income for the same period. As demonstrated by the dotted line in figure 12, the labor's share dropped from above 60 percent at the end of the 18th century to below 50 percent in the middle of the 19th century, whereas the profit's share increased from 20 percent to nearly 50 percent. "Engels's pause" happened here, that is, the real wage lagged behind the rapid growth of output per worker. However, this "pause" changed dramatically from 1840 to 1900, during which the real wage increased by 123 percent and output per worker went up by only 90 percent.

The U-Shape pattern in the movements of labor's share during the British Industrial Revolution is consistent with my panel regression findings using modern-time data for a large number of countries at various development levels. The United Kingdom transformed from a premodern agricultural society to an industrialized economy starting in the late 18th century in a similar way that many newly industrialized economies (NIEs) and developing countries have experienced about 200 years later, though it might have taken the United Kingdom a longer time to finish. According to Allen (2000), the share of labor force in UK agriculture went down from more than 70 percent in 1500 via 55 percent in 1700 to 35 percent in 1800. In 1850, agriculture of the United Kingdom employed one-quarter of the labor force (Clark and Werf 1998).

Economic historians have debated for a long time about the timing of agricultural revolution in the United Kingdom as well as its relationship with the Industrial Revolution. The "revisionists" like Allen (1999) offer new evidence supporting an earlier occurrence of the agricultural revolution that can be dated back to the 1500s. They see the rise of agricultural productivity and output had facilitated the debouchment of the Industrial Revolution. In fact, this view echoes many prominent researchers in the growth and development literature, as by Jorgenson (1961, 1967), Matsuyama (1992), and most recently Gollin, Parente, and Rogerson (2002, 2007), who emphasize the importance of food problems and the essential effect of the agricultural revolution on releasing the much-needed resources to the juvenile modern economic sector. An up-to-date example is unquestionable impact of the green revolution on development. I will build a growth model in *section 5* following this line of argument.

Most recently, according to the EU KLEMS database, the United Kingdom reached its peak of labor's share in 1975 at 70 percent. Using five-year averages, its share decreased from 67 percent (1975–79) to 63 percent (2000–2004). During the same period, its financial sector remarkably increased from 13 percent of GDP to 30 percent. The labor's share within the financial sector went down from 51.7 percent to 46.9 percent, which is significantly lower than the aggregate labor's share in the national economy.

In short, the full development process of the first industrial economy in human history presents a perfect example of the cubic relationship between the labor's income and the average income level.

4.2 The United States, 1790–1900

Is the United States special? A brief answer is no. My major data sources are the US Census Bureau (1975) and Carter et al. (2006), which cover a wide range of economic time series dating back to the colonial times. I illustrate the historical evolution of the American labor's income and per capita GDP level in figure 13. To make the long-run data series consistent, I use the wage share in the national income as a proxy of labor's share.

In the beginning of these time series, the GDP per capita of the United States was at US$1,200 (in 2000 constant US dollars) in 1790, and then gradually rose to US$3,000 (the supposed turning point) toward the end of the 1870s. The US economy experienced a phenomenal industrialization during the second half of the 19th century. In 1860, more than 60 percent of the total labor force was still employed on farms, which were producing 35 percent of the total GDP, and the per capita GDP level was at US$2,300. My calculation shows that the ratio of all workers' wages to the GDP was around 70 percent then. Ten years later (in figure 13 I interpolate and connect 1860 and 1870 labor's share points with a dotted line, due to the lack of data in between), this ratio went down to 60 percent ending in 1870. Labor's share continued to decline to below 50 percent in 1880. From then on this downward trend was just reversed. In the next 10 years, from 1880 to the 1890s, the wage's share in GDP gained 10 percent, gradually returning to 60 percent. In 1900 the share of farms' value added in GDP decreased to 20 percent. Since 1900, the wage's share in GDP has been stabilized at around 65 percent (except for the period of the Great Depression), during which time the Kaldor Fact had been generally applicable.

Therefore, the United States was not very different from other countries in terms of the industrialization process, although the United States completed it in a faster pace than the United Kingdom and much earlier than most of the other countries. For the modern part of US economic development, a Solow growth model with a constant labor's share of 65 percent could be a very good approximation of the real economy (good enough for modern economic analysis and forecast); however, when I need to seriously study the premodern and industrialization stages of the American economy, I probably cannot take the constancy of labor's share for granted and might want to further scrutinize the historical data.

4.3 Japan, 1955–2000

Japan's postwar economic development also defies the constancy of the labor's share. I draw the Japanese labor's share and real GDP per capita for the post WWII period in figure 14. In 1955, the labor's share in the national income of Japan was as low as 44 percent, and its GDP per capita was at US$3,100, exactly surpassing the first turning point. In 40 years, Japan's aggregate labor's share had risen to 61 percent ending in 1998, according to the Japanese official sources. In addition, very comparable to other highly developed countries, the value-added share of Japan's finance, insurance, real estate, and business services sector increased from 15 percent to 25 percent from the end of the 1970s to 2000.

4.4 Summary

The generalized fact of the cubic form movements in labor's share is not only applicable to nowadays developing countries: It seems to describe a universal story of economic transformations, no matter when it happened, be it the late 1700s in the United Kingdom, the second half of 19th century in the United States, the 1950s through the 1970s in Japan, the 1970s through the 1990s in Korea, or the present in China and India.

5 TOWARD A GROWTH MODEL OF UNBALANCED TRANSFORMATION

In this section, I build a neoclassical two-sector growth model based on CES production function. This model intends to explain the nonlinear and nonmonotonous movements of labor's share during long-run growth, especially during structural transformations. I take the first grand transformation as my baseline case and build an explicit model to explore the mechanism behind this important structural change, i.e., from the premodern agricultural society to the industrial economy.

5.1 Consumer's Problem

I specify the consumer's preference structure in terms of Engel's law, one of the most robust empirical findings in economics. Recent formulations along this line include Kongsamut, Rebelo, and Xie (2001), and Gollin, Parente, and Rogerson (2007). I take a preference form very close to Gollin, Parente, and Rogerson (2007). Typical infinite-lived households have preferences as (11),

$$U = \int_0^\infty e^{-\rho t} \cdot u(a_t, m_t)\, dt \quad (11)$$

$$u(a_t, m_t) = \begin{Bmatrix} a_t, & if\ a_t < \bar{a} \\ \frac{m_t^{1-\theta}-1}{1-\theta} + \bar{a} & if\ a_t\ ?\ \bar{a} \end{Bmatrix} \quad (12)$$

Consumption is composed of two goods, which are both in per capita terms, the traditional agricultural goods *a* and the modern goods *m* (composed of manufactures and traditional services). This is a simplified version of the Engel's law, combining a subsistence level of food consumption and a standard constant relative risk aversion (*CRRA*) preference. Before a threshold $\bar{a}$ is reached, which is the subsistence level, all household consumption is concentrated in agricultural goods. After the threshold $\bar{a}$ is reached, consumption of agricultural goods is kept at $\bar{a}$.

5.2 Producer's Problem

There are two production sectors in the economy: the agricultural sector and the modern sector. Due to nonlinearity of the utility function and limited agricultural productivity in the premodern era, all labor is employed in agriculture. With the improvement of agricultural technology, a modern sector can grow by absorbing the released labor from agriculture. My framework is purely neoclassical and assumes equal marginal productivity of labor across sectors. I adopt CES production functions for the two sectors. For simplicity, I assume Hicks-neutral technologies. Population dynamics are also assumed away.

5.2.1 The Agricultural Sector and the Premodern Society

The production function for the agricultural sector is modeled by (13), in a CES form. Two factors are required for the production: land N and labor L_a. The elasticity of substitution between land and labor in agriculture is σ, a constant According to the seminal work of Arrow et al. (1961), as well as the recent empirical findings of Duffy and Papageorgiou (2000), and Antras (2004), I can assume the elasticity of substitution is below 1, especially for countries at the stage of transformation from the agricultural society to the modern: $\sigma \in [0,1)$.

$$Y_a = A_a \cdot [\alpha \cdot N^{\frac{\sigma-1}{\sigma}} + (1-\alpha) \cdot L_a^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \quad (13)$$

Agricultural technology grows at exogenous speed g_a ,

$$\frac{\dot{A}_a}{A_a} = g_a, \quad A_{a,t} = A_{a,0} \cdot e^{g_a \cdot t} \quad (14)$$

5.2.2 The Modern Sector, Grand Transformation, and Modern Economic Growth

After the threshold of agricultural consumption $\bar{a}$ is reached at time T, the modern sector emerges and some portion of the labor force starts to mitigate to the modern sector. The factor market always clears to get (15). $l_a = L_a / L$, and $l_m = L_m / L$.

$$l_a + l_m = 1 \quad (15)$$

Because the quantity of land is almost fixed, $\frac{N}{L}$ is thus approximately constant. I will normalize $\frac{N}{L}$ to be 1 in the following analysis.

The modern sector utilizes capital K and Labor L_m, following a CES -form (16),

$$Y_m = A_m \cdot [\beta \cdot K^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta) \cdot L_m^{\frac{\varepsilon-1}{\varepsilon}}]^{\frac{\varepsilon}{\varepsilon-1}} \quad (16)$$

ε is the elasticity of substitution in the modern sector, $\in [0,1)$. I normalize the price of agricultural goods $p_a = 1$, with p denoting the price of modern goods relative to the agricultural goods. The modern sector technology follows (17),

$$\frac{\dot{A}_m}{A_m} = g_m, \quad A_m = A_{m,0} \cdot e^{g_m \cdot t} \quad (17)$$

Modern goods are either consumed or invested, whilst agricultural goods are used only for consumption. Thus I have (18) and (19),

$$A_a \cdot [\alpha \cdot N^{\frac{\sigma-1}{\sigma}} + (1-\alpha) \cdot L_a^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} = \bar{a} \cdot L \quad (18)$$

$$A_m \cdot [\beta \cdot K^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta) \cdot L_m^{\frac{\varepsilon-1}{\varepsilon}}]^{\frac{\varepsilon}{\varepsilon-1}} = M_t + \dot{K}_t + \delta K_t \quad (19)$$

Moreover, I assume there is a very small amount of capital k_0 available at time T.

5.3 Competitive Equilibrium

Analysis of the premodern stage is easy because only agricultural goods are produced and consumed. I limit my discussion of the dynamic optimization problem to the period after the modern economy starts (at time T). Then from (18), I can derive (20),

$$A_a \cdot [\alpha + (1-\alpha) \cdot l_a^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} = \bar{a} \quad (20)$$

From (20) I can derive the dynamics of the share of labor allocated to agriculture over time (21), which is solely determined by the technology parameter in agriculture. Therefore, I treat l_a and l_m as exogenous variables.

$$l_{a,t} = \left[\frac{\left(\frac{\bar{a}}{A_a} \right)^{\frac{\sigma-1}{\sigma}} - \alpha}{1-\alpha} \right]^{\frac{\sigma}{\sigma-1}} \quad (21)$$

Applying the market clearing condition (15) to (19) and (21), I get (22),

$$\dot{k}_t = A_m \cdot \left[\beta \cdot k_t^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta) \cdot l_m^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}} - m_t - \delta k_t \quad (22)$$

Therefore, the optimal sequence of choices is $\{ m_t, k_t \}_{t=T}^{\infty}$,

$$\max_{\{m_t, k_t\}_{t=T}^{\infty}} \int_0^{\infty} e^{-\rho(t-T)} \cdot \left[\frac{m_t^{1-\theta} - 1}{1-\theta} + \bar{a} \right] dt \quad (23)$$

subject to the constraint condition (22), (15) and (21).

Then I provide an analytical solution: the current-value Hamiltonian,

$$\tilde{H}(k,m,\mu)=\frac{m_t^{1-\theta}-1}{1-\theta}+\mu_t\cdot\left(A_m\cdot\left[\beta\cdot k_t^{\frac{\varepsilon-1}{\varepsilon}}+(1-\beta)\cdot l_m^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}-m_t-\delta k_t\right) \quad (24)$$

with the state variable k, control variable m, and current-value costate variable μ. The necessary conditions are,

$$\tilde{H}_m(k,m,\mu)=m_t^{-\theta}-\mu_t=0 \quad (25)$$

$$\tilde{H}_k(k,m,\mu)=\mu_t(\beta\cdot A_m\cdot\left[\beta+(1-\beta)\cdot l_m^{\frac{\varepsilon-1}{\varepsilon}}\cdot k_t^{\frac{1-\varepsilon}{\varepsilon}}\right]^{\frac{1}{\varepsilon-1}}-\delta)=\rho\mu_t-\dot{\mu}_t \quad (26)$$

$$\lim_{t\to\infty}e^{-\rho(t-T)}\mu_t\cdot k_t=0 \quad (27)$$

The optimal consumption of the modern goods follows the Euler equation (28),

$$\frac{\dot{m}_t}{m_t}=\frac{1}{\theta}(r-\rho) \quad (28)$$

where r is the real interest rate.

$$\frac{\dot{\mu}_t}{\mu_t}=\rho+\delta-\beta\cdot A_m\cdot\left[\beta+(1-\beta)\cdot l_m^{\frac{\varepsilon-1}{\varepsilon}}\cdot k_t^{\frac{1-\varepsilon}{\varepsilon}}\right]^{\frac{1}{\varepsilon-1}} \quad (29)$$

5.4 Dynamics of labor's share

I will examine the evolution of labor's share within these growth dynamics. The labor's share in agriculture is calculated as (30),

$$S_{La}=\frac{(1-\alpha)\cdot L_a^{\frac{\sigma-1}{\sigma}}}{\alpha\cdot N^{\frac{\sigma-1}{\sigma}}+(1-\alpha)\cdot L_a^{\frac{\sigma-1}{\sigma}}} \quad (30)$$

In the premodern society, all labor is employed in agriculture to meet the subsistence needs, so $L_a = L$. I can get (31),

$$S_{La,\text{ premodern}}=\frac{1-\alpha}{(1-\alpha)+\alpha\cdot\left(\frac{N}{L}\right)^{\frac{\sigma-1}{\sigma}}} \quad (31)$$

Equation (31) shows that the labor share S_{La} in the premodern era is invariant. Moreover, this share is a function of the land per capita when $\sigma \in (0,1), \frac{N}{L} \uparrow \;\; \Rightarrow \;\; S_{La,\text{ premodern}} \uparrow$. That is, land-abundant countries will have relatively high labor's share in national income.

After the modern sector starts, labor's share in agriculture becomes (32),

$$S_{La} = \frac{1-\alpha}{(1-\alpha)+\alpha \cdot l_a^{\frac{1-\sigma}{\sigma}}} \quad (32)$$

Similarly, labor's share in the modern sector is,

$$S_{Lm} = \frac{1-\beta}{(1-\beta)+\beta \cdot \left[\frac{1-l_a}{k}\right]^{\frac{1-\varepsilon}{\varepsilon}}} \quad (33)$$

The aggregate labor share in the national income ϕ can be represented by sectoral value-added composition, as defined by (34) – (35),

$$\phi = \frac{S_{La} \cdot Y_a + S_{Lm} \cdot pY_m}{Y_a + pY_m} = S_{La} \cdot \frac{Y_a}{Y} + S_{Lm} \cdot (1-\frac{Y_a}{Y}) \quad (34)$$

$$p = \frac{A_a \cdot (1-\alpha)}{A_m \cdot (1-\beta)} \frac{\left[(1-\alpha)+\alpha \cdot l_a^{\frac{1-\sigma}{\sigma}}\right]^{\frac{1}{\sigma-1}}}{\left[(1-\beta)+\beta \cdot \left(\frac{l_m}{k_t}\right)^{\frac{1-\varepsilon}{\varepsilon}}\right]^{\frac{1}{\varepsilon-1}}} \quad (35)$$

The relative price of the modern goods to the agricultural goods *p* is determined by (35).

$$\frac{Y_a}{Y} = \frac{A_a \cdot [\alpha+(1-\alpha) \cdot l_a^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}}{A_a \cdot [\alpha+(1-\alpha) \cdot l_a^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} + p \cdot A_m \cdot [\beta \cdot k^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta) \cdot l_m^{\frac{\varepsilon-1}{\varepsilon}}]^{\frac{\varepsilon}{\varepsilon-1}}} \quad (36)$$

I can see from (32) that with the development of the modern sector $l_a \downarrow$, labor's share in agriculture S_{La} increases monotonously. However, according to (33), labor's share in the modern sector is determined by $\frac{1-l_a}{k}$: when the labor allocated to the modern sector $(1-l_a)\uparrow$, and $k \uparrow$, the labor's income share in the modern sector S_{Lm} can demonstrate a nonmonotonous feature, which is decided by the relative movement of *k* and l_m. Otherwise I can only see monotonous dynamics (including the possibility of constancy) in the aggregate labor's share during economic transformation.

In an alternative way, the evolution of the aggregate labor's income share in national income can be described as (37),

$$\phi = \frac{wL}{wL + rK} = \frac{1}{1 + k \cdot \frac{r}{w}} \quad (37)$$

Set $\kappa = k \cdot \frac{r}{w}$ I will analyze the dynamics of κ in the following discussions.

$$\frac{\dot{\kappa}}{\kappa} = \frac{\dot{k}}{k} + \frac{\dot{r}}{r} - \frac{\dot{w}}{w} \quad (38)$$

Wage w is derived as in (39),

$$w = A_m \cdot (1-\beta) \cdot \left[(1-\beta) + \beta \cdot \left(\frac{k_t}{l_m} \right)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{1}{\varepsilon-1}} \quad (39)$$

In combination with (21), the wage level w (relative to the agricultural goods price) is also exogenously determined by A_a and $\bar{a}$ over time.

Interest rate r is calculated as (40),

$$r = \beta \cdot A_m \cdot \left[\beta + (1-\beta) \cdot \left(\frac{k_t}{l_m} \right)^{\frac{1-\varepsilon}{\varepsilon}} \right]^{\frac{1}{\varepsilon-1}} \quad (40)$$

Hence I get (41),

$$\kappa = \frac{\beta}{1-\beta} \cdot k_t \cdot \left[\frac{(1-\beta) + \beta \cdot \left(\frac{k_t}{l_m}\right)^{\frac{\varepsilon-1}{\varepsilon}}}{\beta + (1-\beta) \cdot \left(\frac{k_t}{l_m}\right)^{\frac{1-\varepsilon}{\varepsilon}}} \right]^{\frac{1}{1-\varepsilon}} = \frac{\beta}{1-\beta} \cdot k_t \cdot \left[\frac{k_t}{l_m} \right]^{-\frac{1}{\varepsilon}} \quad (41)$$

So the dynamics of κ are,

$$\frac{\dot{\kappa}}{\kappa} = \frac{1}{\varepsilon} \cdot \frac{\dot{l}_m}{l_m} - \left(\frac{1}{\varepsilon} - 1\right) \cdot \frac{\dot{k}}{k} \quad (42)$$

Because labor's share is,

$$\phi = \frac{1}{1+\kappa} \quad (43)$$

To make labor's share constant, I must have (44),

$$k_t = \left(l_m \right)^{\frac{1}{1-\varepsilon}} \quad (44)$$

From (21), I can see that the employment share in the agricultural and modern sectors is only determined by the technology growth rate in agriculture, with the neoclassical assumption. Labor's share will evolve in different patterns under the following two conditions:

- $k_t > (l_m)^{\frac{1}{1-\varepsilon}}$: $\frac{\dot{\phi}}{\phi} > 0$ labor's share will increase from t
- $k_t < (l_m)^{\frac{1}{1-\varepsilon}}$: $\frac{\dot{\phi}}{\phi} < 0$ labor's share will decrease from t

The intuition behind these dynamics is, if the agriculture releases more labor than the modern sector can easily absorb, the wage rate will be brought down relatively. In the beginning of modern economic take-off, capital is comparatively rare, thus demanding higher return. However, κ will keep growing and finally labor turns out to be the relatively scarce factor. This will reverse the downward trend in the movements of labor's share in the economy.

5.5 A Simple Simulation

In this section, I conduct a simple calibration and simulation for the above-discussed growth model. As an important example, I try to test whether a nonmonotonous pattern of movement in labor's share could really emerge from my proposed model during the British Industrial Revolution. My model-based simulation tracks quite well with the empirical evidence provided by Allen (2007). The proposed multi-sector CES growth model is helpful for understanding the nonlinearity in the movements of labor's share during economic transformations. The details of simulation will be provided later.

6 CONCLUSIONS

In this paper I present a new set of evidence to characterize the long-run evolvement of labor's share accompanying the modern economic development. The movements of labor's share demonstrate a nonlinear and nonmonotonous pattern after the debut of the modern economic sector. I summarize this as a *generalized fact* that labor's share tracks a cubic relationship with the economic development level, due to the grand economic transformations. I have further explored the evidences from economic history and confirmed this generalized relationship is also applicable to the earlier development stage of the United Kingdom and the United States, whose contemporary economic time series (summarized by the Kaldor fact) inspired the standard modern growth theory. The Kaldor fact however can be seen as a special case focusing on the relatively stable portion upon the long cubic curve. The mainstream Cobb-Douglas class growth models are not able to capture the nonmonotonous pattern in the labor's share movements, while my proposed two-sector CES-form model is qualified for explaining this dynamics. Calibration and simulation based on the proposed growth model fit the historical facts fairly well.

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APPENDIX

Table A1 Labor's share and real GDP per capita, 1950–2003

Commodity exporters removed

Variables	**(1) Yearly, FE**	**(2) Yearly, FE**	**(3) 5Y Avg, FE**	**(4) 5Y, FE**	**(5) 5Y, FE**	**(6) 5Y, FE**
1n(*rgdpch*)	−274.8***	−301.5***	−235.4***	−245.7***	−18.54**	−751.0
	(34.47)	(33.70)	(70.21)	(68.57)	(8.753)	(589.4)
$[1n(rgdpch)]^2$	30.98***	33.95***	26.59***	27.59***	1.202**	118.9
	(3.960)	(3.872)	(8.173)	(7.986)	(0.512)	(105.0)
$[1n(rgdpch)]^3$	−1.141***	−1.248***	−0.979***	−1.009***		−8.243
	(0.151)	(0.147)	(0.315)	(0.308)		(8.250)
$[1n(rgdpch)]^4$						0.212
						(0.241)
Year		−0.110***		−0.111***		
		(0.0168)		(0.0365)		
Constant	840.2***	1140***	726.0***	978.2***	116.0***	1795
	(99.32)	(103.2)	(199.6)	(206.7)	(38.15)	(1230)
Observations	2037	2037	463	463	463	463
R^2	0.100	0.063	0.087	0.064	0.062	0.089
# Countries	101	101	101	101	101	101

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Robust standard errors in parentheses. The removed commodity exporters: BHR BRN QAT TTO ARE OMN GAB SAU DZA KAZ NGA YEM MNG VEN IRN ZMB CHL NOR AZE MOZ BOL RUS CIV BLR.

Source: Author's calculations.

Table A2 Labor's share and development with standard controls, 1950–2003

Five-year panels with country and time FE, commodity exporters removed

	(1)	(2)	(3)	(4)	(5)
1n(*rgdpch*)	–349.0***	–348.2***	–437.9***	–438.8***	–814.1***
	(92.41)	(91.82)	(96.72)	(96.90)	(122.5)
[1n(*rgdpch*)]^2	40.19***	40.02***	50.98***	51.07***	92.56***
	(10.95)	(10.88)	(11.49)	(11.51)	(14.17)
[1n(*rgdpch*)]^3	–1.521***	–1.514***	–1.950***	–1.953***	–3.475***
	(0.430)	(0.427)	(0.451)	(0.452)	(0.544)
1n(*School Year*)	–2.480	–3.660*	–3.228	–3.453	–6.362*
	(2.013)	(2.072)	(2.163)	(2.243)	(3.345)
[1n(*School Year*)]^2		1.770**	1.343	(1.373)	2.187**
		(0.809)	(0.848)	(0.853)	(1.093)
Investment	0.153*	0.159*	0.153*	0.157*	0.108
	(0.0867)	(0.0862)	(0.0891)	(0.0898)	(0.0870)
Population growth	–0.0281	0.309	0.501	0.539	0.186
	(0.559)	(0.576)	(0.602)	(0.611)	(0.582)
Institution			–0.0428	–0.0409	–0.00624
			(0.0428)	(0.0391)	(0.0373)
Openness				–0.00773	–0.0164
				(0.0200)	(0.0193)
1n(inf *lation*)					–1.074***
					(0.335)
Constant	1042***	1041***	1280***	1283***	2414***
	(258.5)	(256.8)	(269.6)	(270.2)	(352.8)
Observations	388	388	368	368	351
R^2	0.118	0.132	0.151	0.152	0.257
# Countries	81	81	78	78	74

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Robust standard errors in parentheses. The removed commodity exporters are the same as in table A1.

Source: Author's calculations.

Table 1 Correlation between the operating surplus of private unincorporated enterprises (OSPUE) and naive definitions

Variables	(1) Correlation	(2) Pooled	(3) Panel, FE
LaborShare$_{Naive}$	0.737	0.629***	1.108***
		(0.0332)	(0.0252)
Constant		27.40***	4.288***
		(1.766)	(1.219)
Observations		855	855
R^2		0.543	0.709
# Countries			61

*** p < 0.01, ** p < 0.05, * p < 0.1

Note: Robust standard errors in parentheses.

Source: Author's calculations.

Table 2 Labor's share and real GDP per capita, 1950–2003

Variables	(1) Yearly, FE	(2) Yearly, FE	(3) 5Y Avg, FE	(4) 5Y, FE	(5) 5Y, FE	(6) 5Y, FE
1n(*rgdpch*)	−283.8***	−311.2***	−249.0***	−262.7***	−14.41*	−832.6
	(34.10)	(33.39)	(69.14)	(67.65)	(8.640)	(588.2)
[1n(*rgdpch*)]^2	32.21***	35.26***	28.35***	29.78***	0.972*	132.6
	(3.909)	(3.827)	(8.022)	(7.853)	(0.499)	(104.6)
[1n(*rgdpch*)]^3	−1.196***	−1.306***	−1.052***	−1.099***		−9.238
	(0.148)	(0.145)	(0.308)	(0.302)		(8.199)
[1n(*rgdpch*)]^4						0.239
						(0.239)
Year		−0.104***		−0.124***		
		(0.0151)		(0.032)		
Constant	861.1***	1149***	757.4***	1046***	95.54**	1970
	(98.52)	(101.6)	(197.2)	(203.7)	(38.08)	(1229)
Observations	2406	2406	552	552	552	552
R^2	0.088	0.056	0.087	0.066	0.062	0.089
# Countries	123	123	123	123	123	123

*** p < 0.01, ** p < 0.05, * p < 0.1

Note: Robust standard errors in parentheses.

Source: Author's calculations.

Table 3 Labor's share and development with standard controls, 1950–2003

Five-year panels with country and time fixed effects

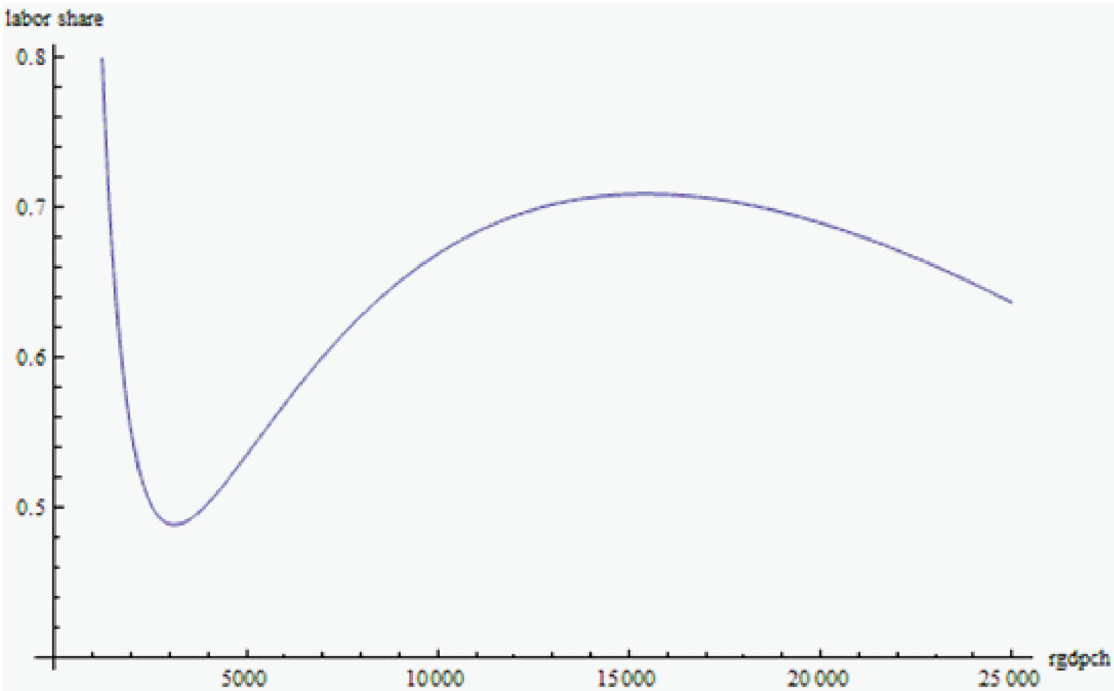
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
1n(*rgdpch*)	–351.8***	–357.4***	–439.6***	–439.3***	–746.7***
	(87.53)	(87.13)	(91.48)	(91.71)	(115.6)
$[1n(rgdpch)]^2$	40.92***	41.56***	51.63***	51.59***	85.12***
	(10.33)	(10.28)	(10.82)	(10.84)	(13.28)
$[1n(rgdpch)]^3$	–1.567***	–1.594***	–1.996***	–1.994***	–3.208***
	(0.403)	(0.401)	(0.423)	(0.424)	(0.506)
1n(*School Year*)	–3.722**	–5.007***	–4.682**	–4.633**	–6.353**
	(1.750)	(1.845)	(1.911)	(2.034)	(2.773)
$[1n(School\ Year)]^2$		1.633**	1.233	1.229	1.837*
		(0.775)	(0.808)	(0.812)	(1.010)
Investment	0.134*	0.144*	0.128*	0.127	0.0802
	(0.0750)	(0.0748)	(0.0773)	(0.0781)	(0.0763)
Population growth	0.0619	0.357	0.520	0.514	0.0305
	(0.537)	(0.552)	(0.574)	(0.582)	(0.567)
Institution			–0.0320	–0.0324	0.00167
			(0.0377)	(0.0380)	(0.0371)
Openness				0.00140	–0.00691
				(0.0193)	(0.0189)
1n(inf *lation*)					–1.078***
					(0.293)
Constant	1042***	1057***	1276***	1275***	2214***
	(245.9)	(244.8)	(256.1)	(256.8)	(334.6)
Observations	440	440	420	420	402
R^2	0.107	0.119	0.135	0.135	0.221
# Countries	92	92	89	89	85

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Robust standard errors in parentheses.

Source: Author's calculations.

Figure 1 Labor's share and real GDP per capita



Source: Author's calculations.

Table 4 Evolution in the sectoral labor's share, OECD: 1975–2000

	Labor's share	Agriculture (A, B)		Industry (C, D, E, F)		Financial svc (J, K)		Nonfinance svc (G, H, I, L–Q)	
	(1)	(2)		(3)		(4)		(5)	
		Lshare	VA	Lshare	VA	Lshare	VA	Lshare	VA
1975–1979 *Avg*	58.9	18.10	5.9	64.0	36.3	35.6	16.2	69.6	41.5
2000–2004 *Avg*	55.6	23.80	2.2	56.0	27.4	38.6	26.7	67.6	43.6
Δ [1975–2000]	–3.3	5.70	–3.7	–8.0	–8.9	3.0	10.5	–2.1	2.1
$\bar{l}_{i,1975}$		–40.74		5.12		–23.26		10.75	
$\bar{l}_{i,2000}$		–31.75		0.43		–17.00		11.98	
(1) $v_{i,t} \cdot \Delta l_i$	–2.9	0.34		–2.90		0.48		–0.86	
(2) $v_{i,t} \cdot \bar{l}_{i,t}$	0.1	–2.41		1.86		–3.77		4.47	
(3) $\Delta v_i \cdot \Delta l_i$	0.8	–0.21		0.71		0.31		–0.04	
(4) $\Delta v_i \cdot \bar{l}_{i,t}$	–1.2	1.51		–0.46		–2.44		0.23	
(1) + (3) + (4)	–3.3	1.64		–2.64		–1.65		–0.67	

Notes: Lshare denotes labor's share (percent); VA: the share of sectoral value-added in GDP (percent). Letters in brackets following sector names correspond to the industrial code of ISIC rev. 3.

Source: EU KLEMS database.

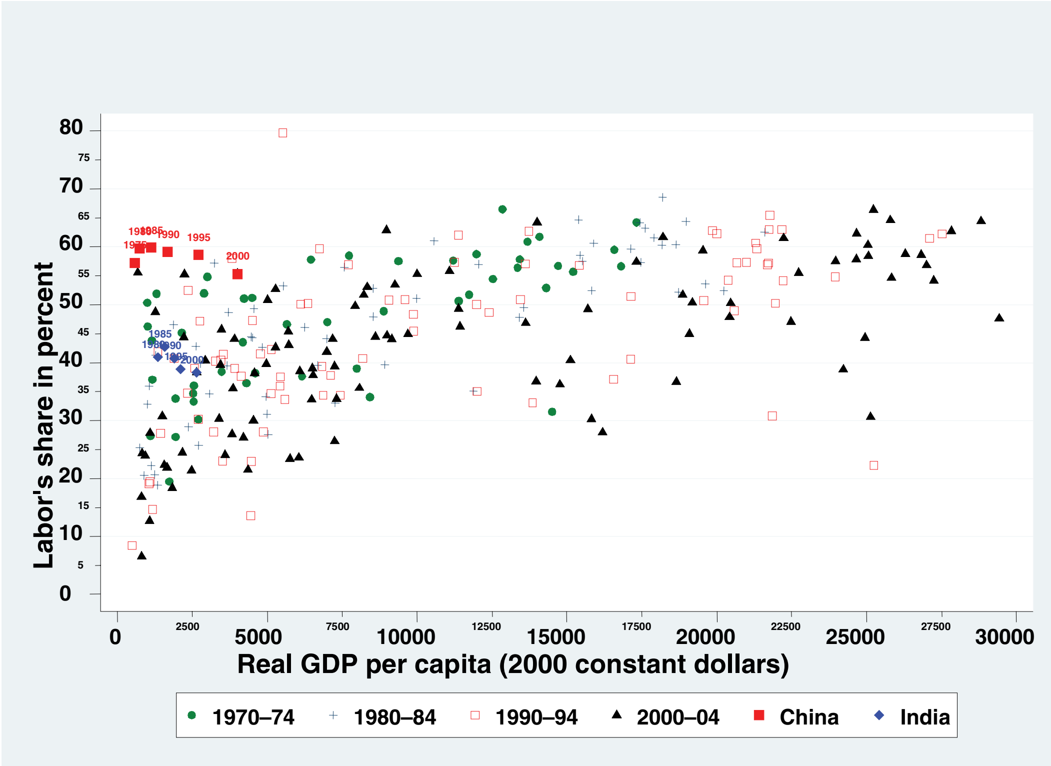
Table 5 Decomposing changes within the financial sector, OECD: 1975–2000

	Financial intermediation (J)		Real estate, renting and business activities (K)		Real estate (ISIC rev. 3: 70)	
	(1)		(2)		(3)	
	Lshare	VA	Lshare	VA	Lshare	VA
1975–1979 *Avg*	56.6	5.1	27.2	11.2	6.9	6.6
2000–2004 *Avg*	54	6.7	34.2	20.1	6.1	9.9
Δ [1975–2000]	–2.7	1.6	7	8.9	–0.8	3.4
$\bar{l}_{i,1975}$	–2.23		–31.71		–52.00	
$\bar{l}_{i,2000}$	–1.61		–21.38		–49.54	
(1) $v_{i,t} \cdot \Delta l_i$	–0.13		0.79		–0.05	
(2) $v_{i,t} \cdot l_{i,t}$	–0.11		–3.54		–3.41	
(3) $\Delta v_i \cdot \Delta l_i$	–0.04		0.63		–0.03	
(4) $\Delta v_i \cdot l_{i,t}$	–0.04		–2.82		–1.75	
(1) + (3) + (4)	–0.21		–1.41		–1.84	

Note: Column (3), the real estate sector (ISIC rev. 3: 70) is a subsector of column (2) (ISIC rev. 3: K).

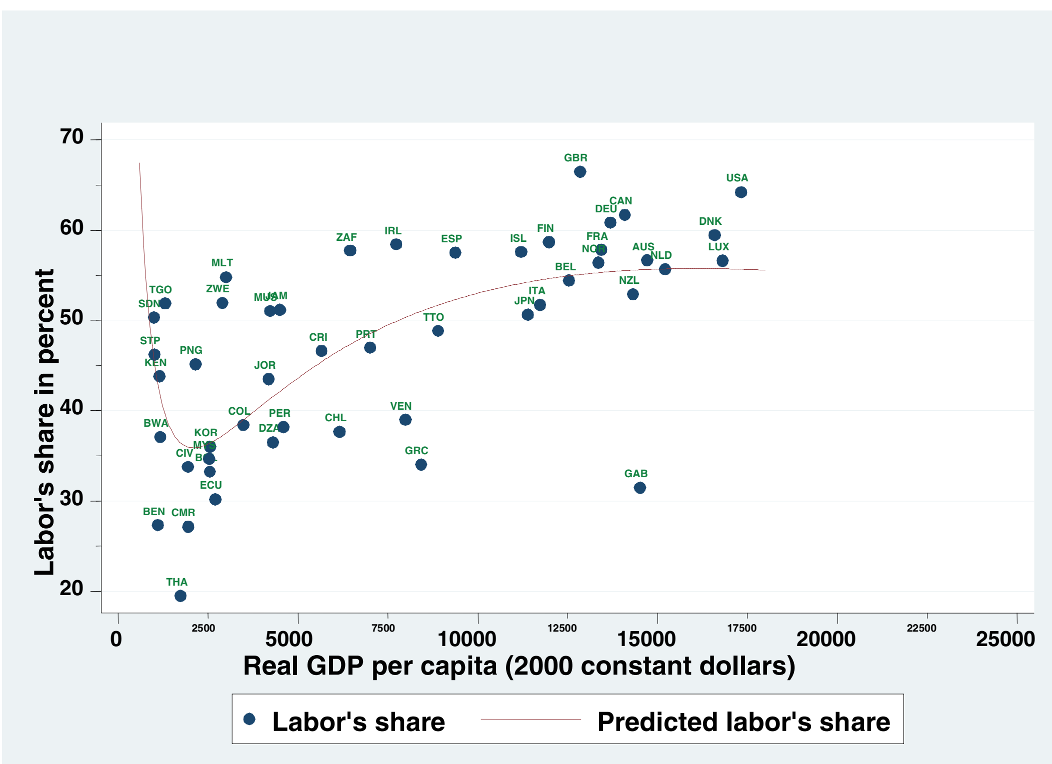
Source: EU KLEMS database.

Figure 2 Evolution of labor's share, 1970–2000



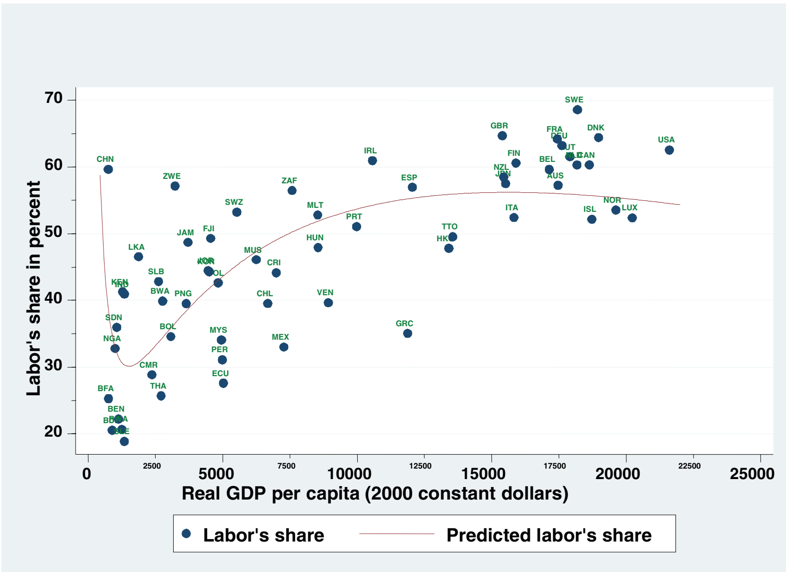
Source: Author's calculations.

Figure 3 Cross-country comparison of the labor's share, 1970–74 average



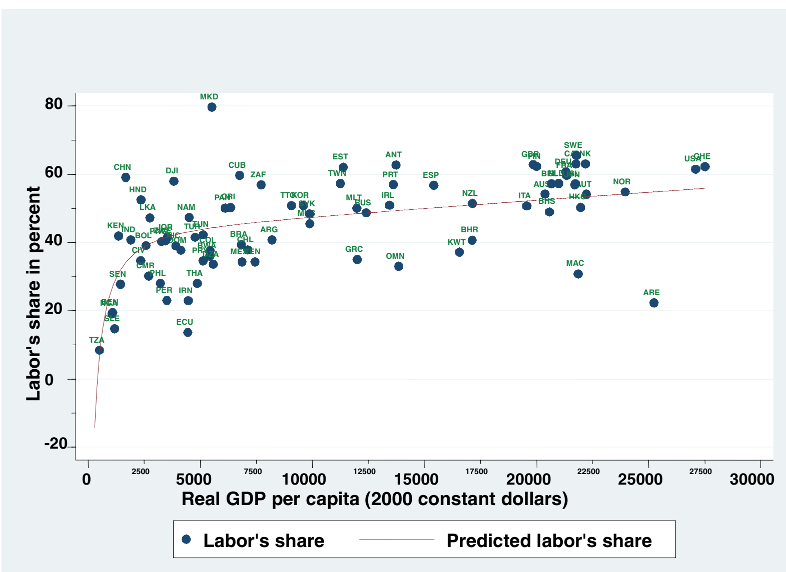
Source: Author's calculations.

Figure 4 Cross-country comparison of the labor's share, 1980–84 average



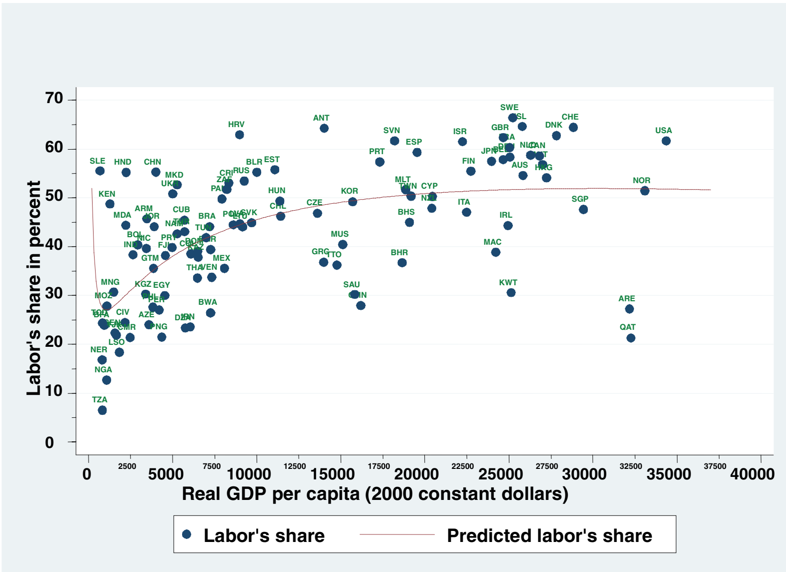
Source: Author's calculations.

Figure 5 Cross-country comparison of the labor's share, 1990–94 average



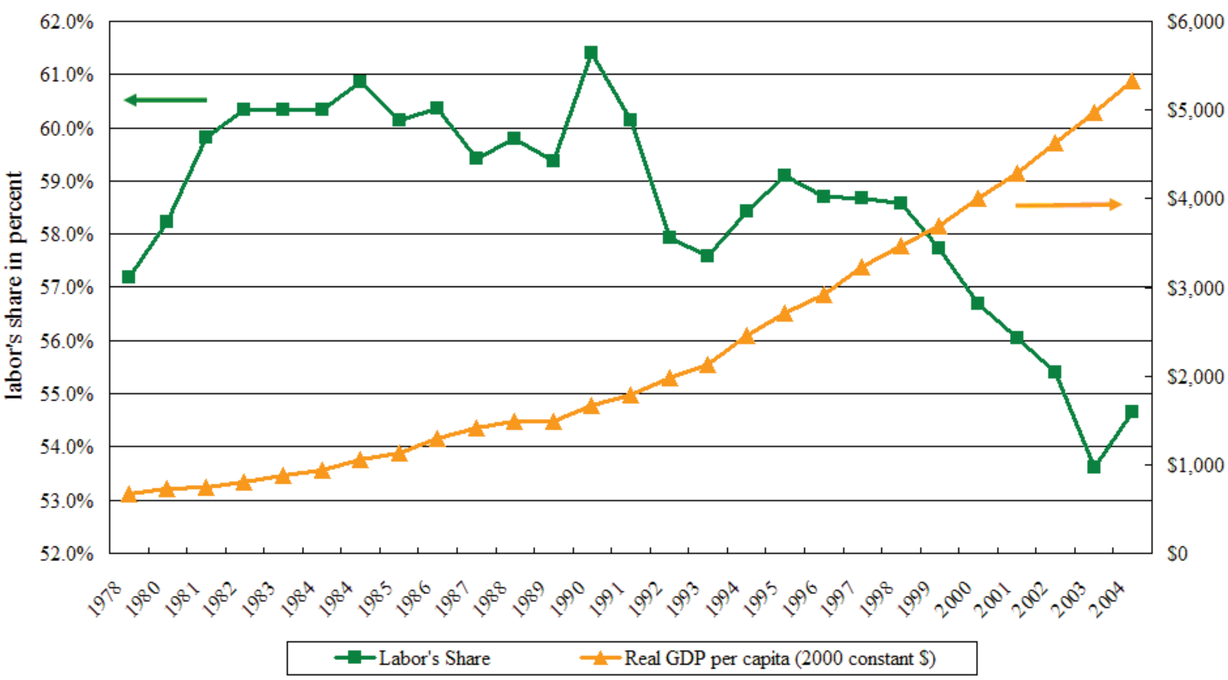
Source: Author's calculations.

Figure 6 Cross-country comparison of the labor's share, 2000–2004 average



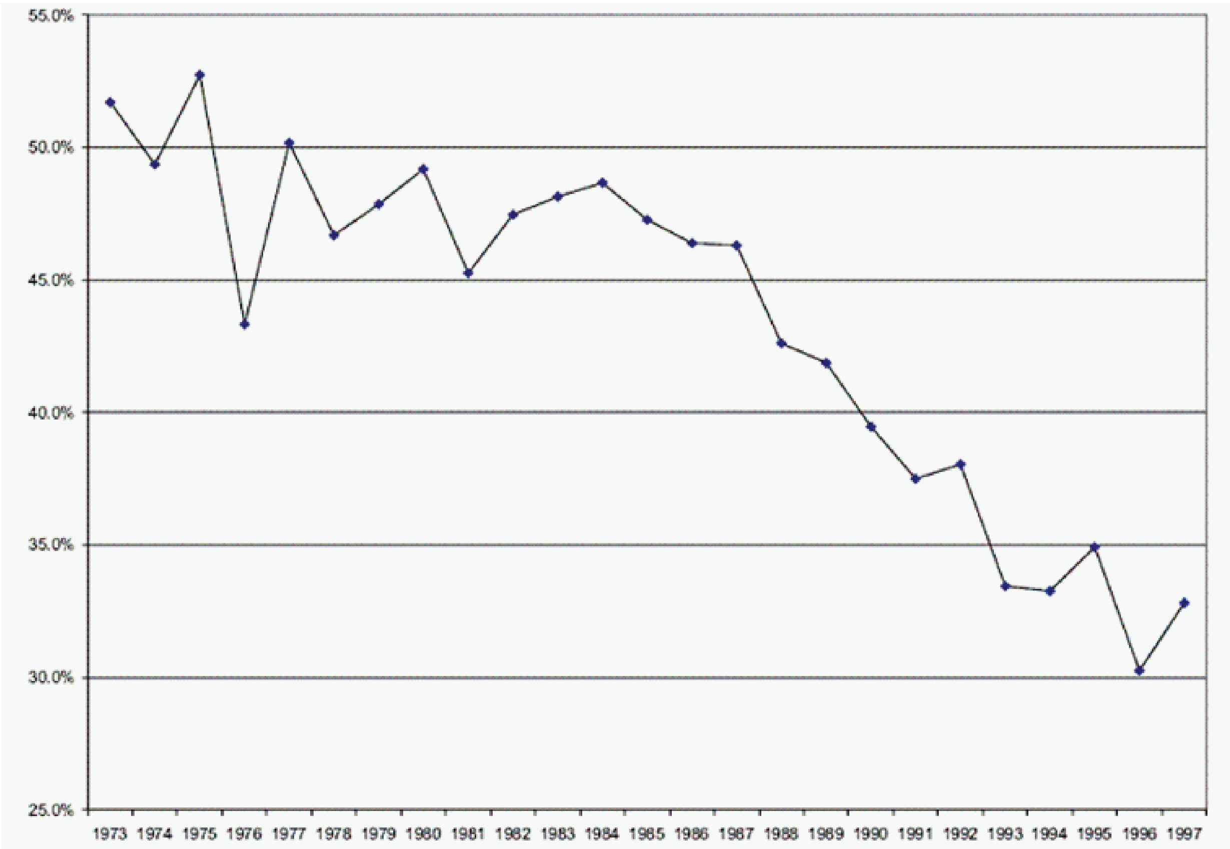
Source: Author's calculations.

Figure 7 Labor's Share of China, 1978–2004



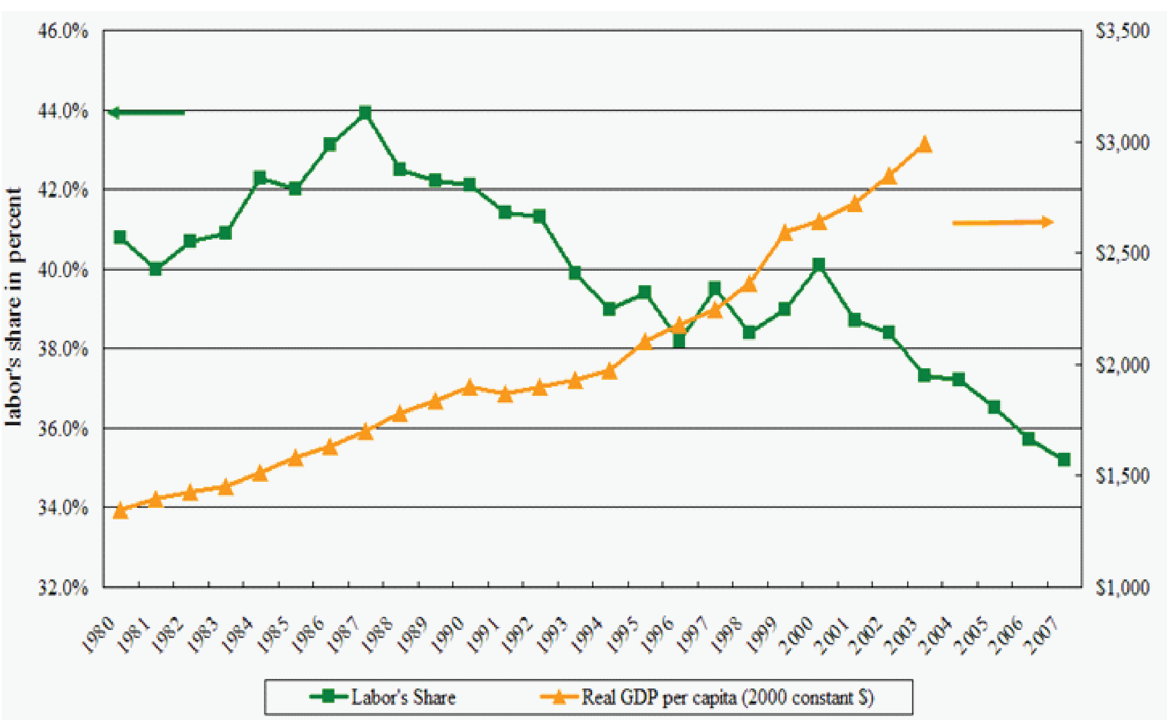
Note: Data of Labor's Share from Bai and Qian (2009); Real GDP from PWT6.2

Figure 8 Wage share in organized Indian manufacturing, 1973–97



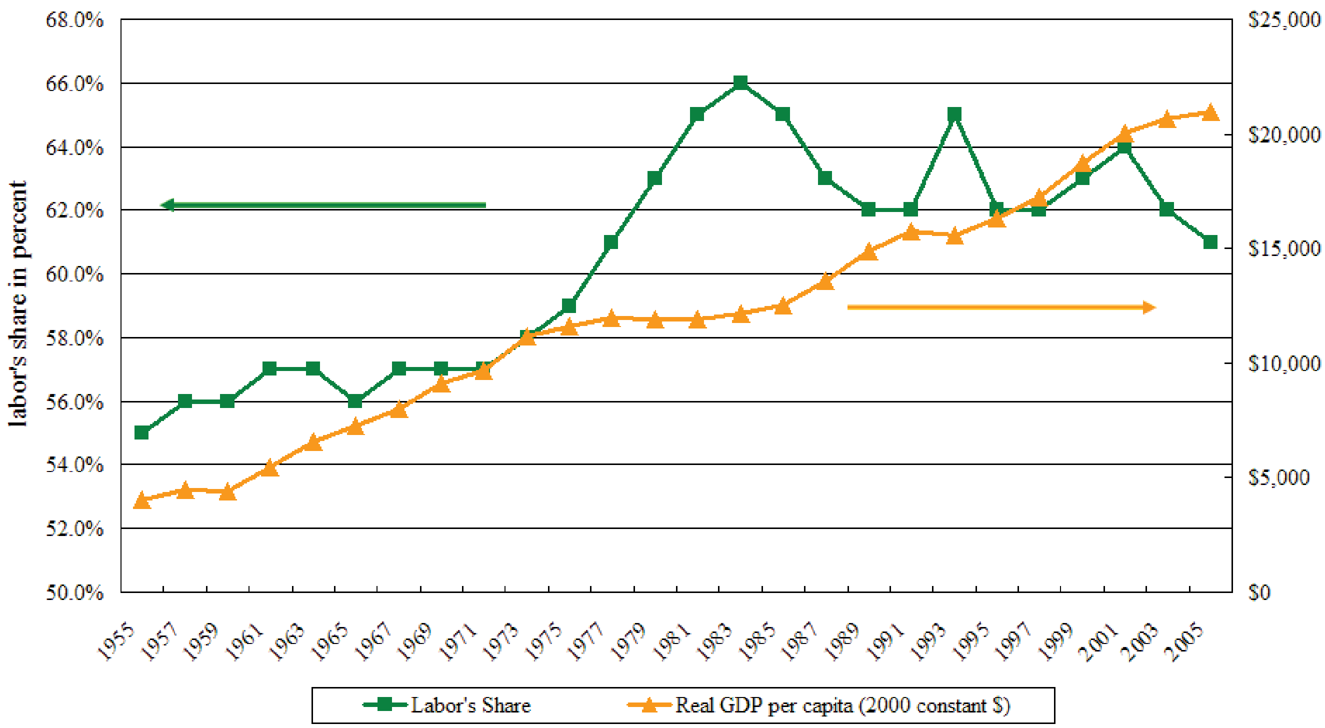
Source: Shastri and Murthy (2006).

Figure 9 Labor's Share of India, 1980–2007



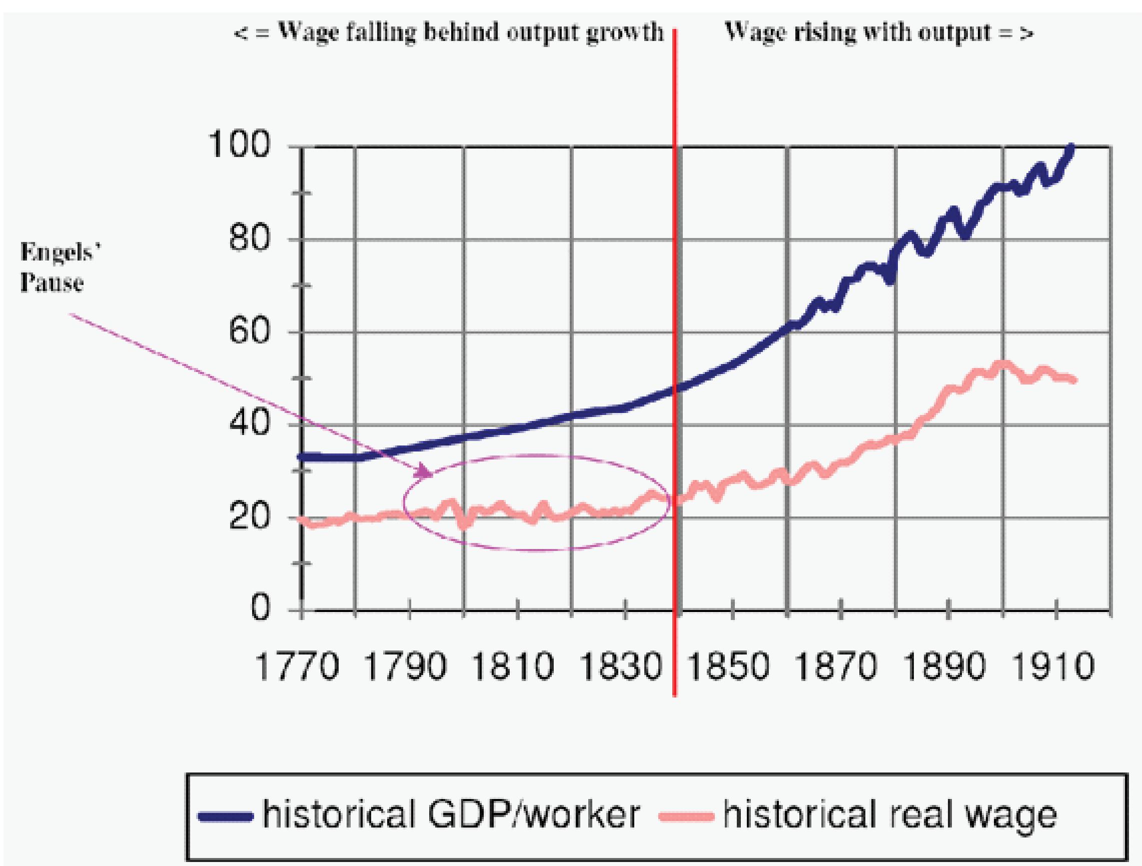
Note: Labor's Share from National Sources; Real GDP from PWT6.2

Figure 10 Labor's Share of Spain, 1955–2005



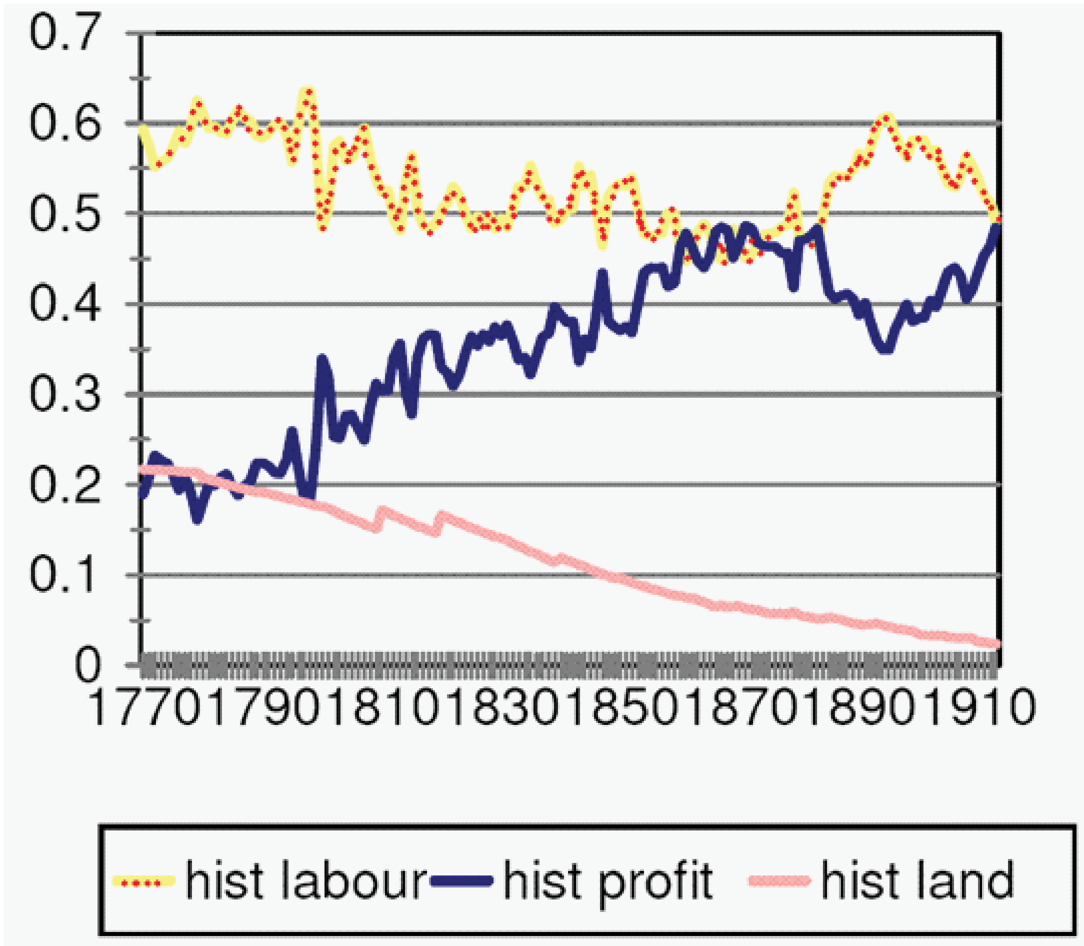
Source: Data of Labor's Share from Ruiz (2005); Real GDP from PWT6.2

Figure 11 British wage and GDP since the Industrial Revolution



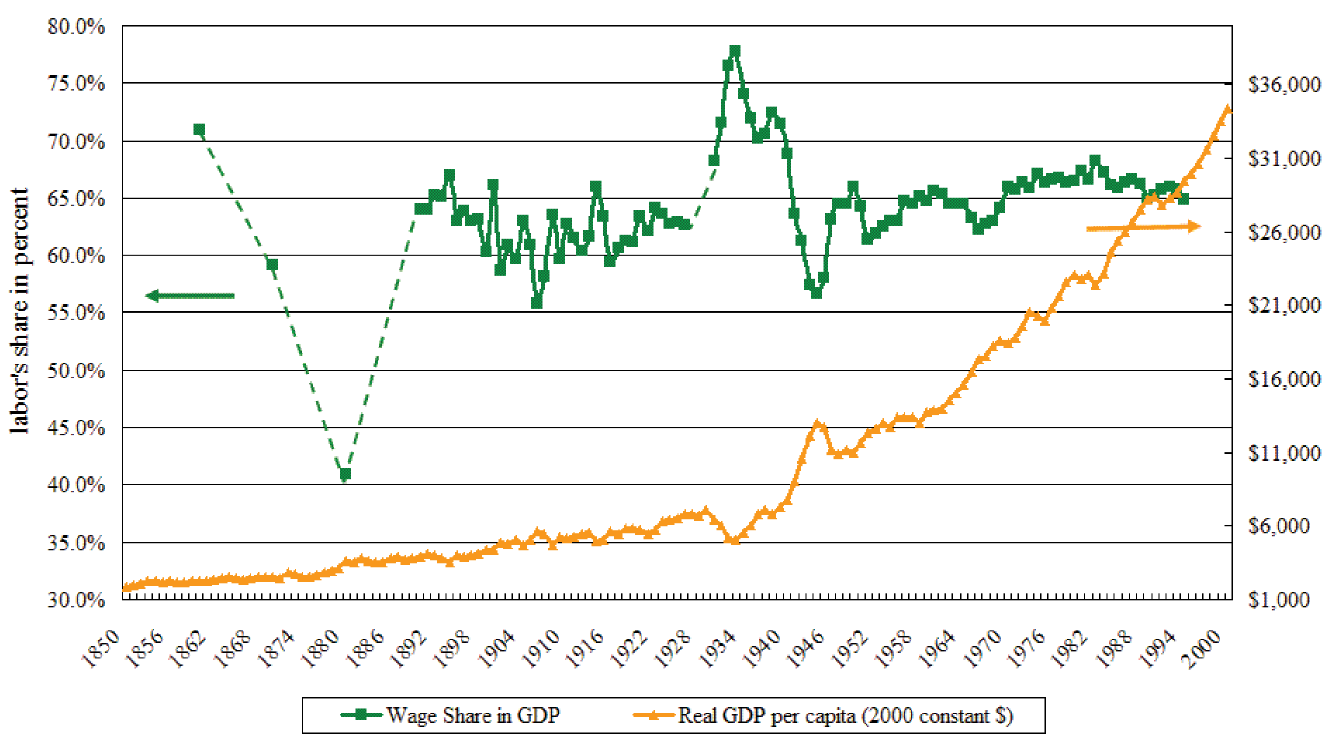
Source: Allen 2007.

Figure 12 Historical factor shares, the United Kingdom: 1770–1913



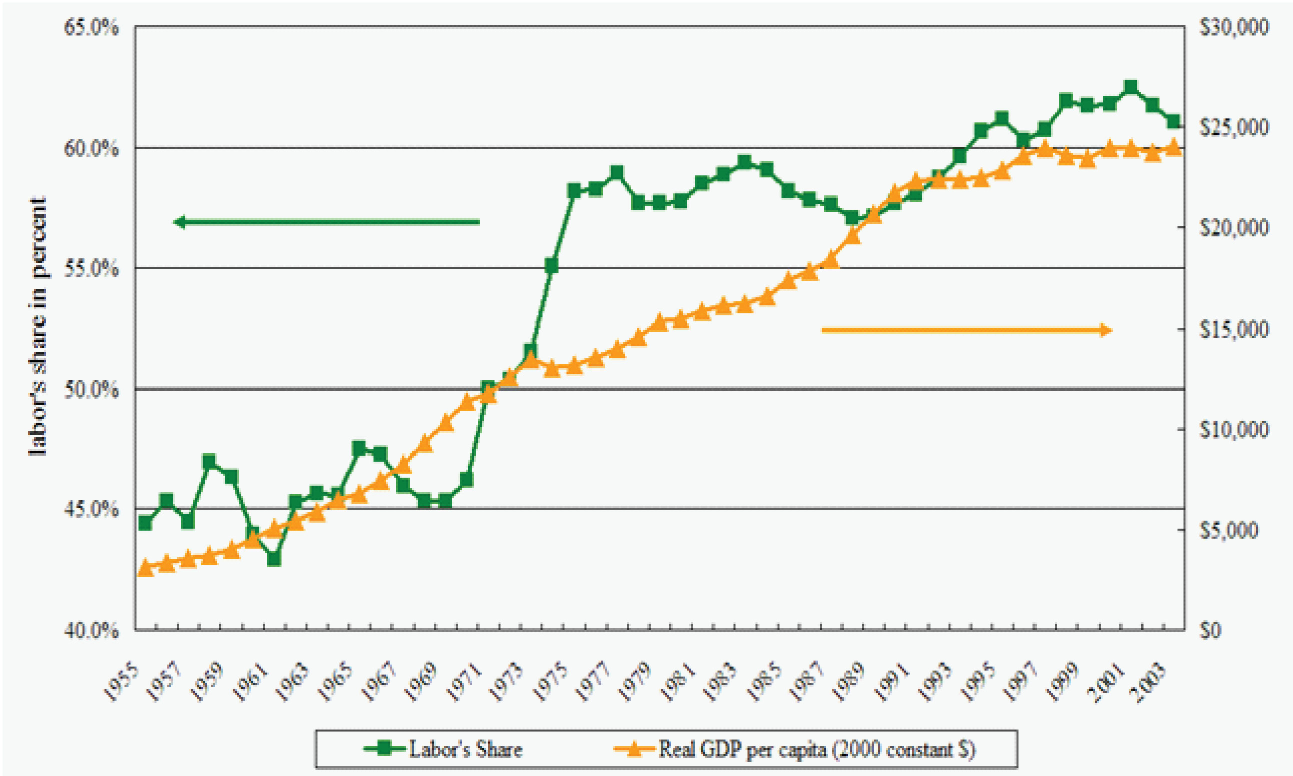
Source: Allen 2007.

Figure 13 Labor's Share of the United States, 1850–2000



Note: Data from *Historical Statistics of the United States*

Figure 14 Labor's Share of Japan, 1955–2003



Source: Labor's Share from Official Sources; Real GDP from PWT6.2